

## Claims

- 1 1. A quantum information processing element comprising  
2 a cage defining a cavity formed from a plurality of self-assembling protein molecules,  
3 and  
4 one or more cargo elements located within the cavity, wherein at least one of the cargo  
5 elements comprises a qubit programmable into a plurality of logical states.
- 1 2. A quantum information processing element according to claim 1, comprising receptors  
2 for capturing and positioning one or more cargo elements within the cavity.
- 1 3. A quantum information processing element according to claim 2, comprising a vesicle  
2 located within the cage and enclosing one or more cargo elements, wherein the receptors extend  
3 through the vesicle to capture and position a cargo element within the vesicle.
- 1 4. A quantum information processing element according to claim 3, comprising adaptors  
2 disposed between the receptors and the cage and binding to the receptors.
- 1 5. A quantum information processing element according to claim 1, comprising a vesicle  
2 located within the cage and enclosing the one or more cargo elements.
- 1 6. A quantum information processing element according to claim 1, comprising molecular  
2 tethers for capturing and positioning one or more cargo elements within the cavity.
- 1 7. A quantum information processing element according to claim 1, comprising direct cage  
2 bonding for capturing and positioning one or more cargo elements within the cavity.
- 1 8. A quantum information processing element according to claim 1, comprising receptors,  
2 molecular tethers and direct cage bonding for capturing and positioning one or more cargo  
3 elements within the cavity.
- 1 9. A quantum information processing element according to claim 1, comprising one or more  
2 cargo elements forming a non-permeable cavity.
- 1 10. A quantum information processing element according to claim 3, comprising a vesicle  
2 forming a non-permeable cavity.
- 1 11. A quantum information processing element according to claim 1, comprising a self-  
2 assembling cage that is electrically neutral and inhibits charge transfer between the cage and its  
3 enclosed cargo elements.

- 1 12. A quantum information processing element according to claim 1, comprising a self-  
2 assembling cage that reduces the tendency of a plurality of logical states in a coherent state to  
3 collapse into a decoherent state.
- 1 13. A quantum information processing element according to claim 1, comprising a non-qubit-  
2 only cage that inhibits non-quantum information processing cargo elements from interfering with  
3 qubit cargo element operation in other cages.
- 1 14. A quantum information processing element according to claim 3, comprising a self-  
2 assembling vesicle that is electrically neutral and inhibits charge transfer between the vesicle and  
3 its enclosed cargo elements.
- 1 15. A quantum information processing element according to claim 3, comprising a self-  
2 assembling insulative vesicle that reduces the tendency of a plurality of logical states in a  
3 coherent state to collapse into a decoherent state.
- 1 16. A quantum information processing element according to claim 4, comprising self-  
2 assembling receptors and adaptors that are electrically neutral and inhibit charge transfer  
3 between the vesicle and cage and their enclosed cargo elements.
- 1 17. A quantum information processing element according to claim 1, comprising a self-  
2 assembling cage that reduces contaminant background radiation to cargo carried within the cage.
- 1 18. A quantum information processing element according to claim 3, comprising a self-  
2 assembling vesicle that reduces contaminant background radiation to cargo carried within the  
3 vesicle.
- 1 19. A quantum information processing element according to claim 1, comprising a self-  
2 assembling framework of cages to structurally support one or more self-assembling QIP  
3 elements.
- 1 20. A quantum information processing element according to claim 1, comprising a self-  
2 assembling electrically neutral substrate of cages to structurally support one or more self-  
3 assembling QIP elements.
- 1 21. A quantum information processing element according to claim 1, comprising a self-  
2 assembling framework of cages to structurally order one or more self-aligning QIP elements.
- 1 22. A quantum information processing element according to claim 1, wherein a cage is empty  
2 and includes no cargo elements.

- 1 23. A quantum information processing element according to claim 1, wherein the one or  
2 more cargo elements is a single cargo element comprising a qubit programmable into a plurality  
3 of logical states.
- 1 24. A quantum information processing element according to claim 1, wherein the one or  
2 more cargo elements are a plurality of cargo elements.
- 1 25. A quantum information processing element according to claim 24, wherein the plurality  
2 of cargo elements are qubits programmable into a plurality of logical states.
- 1 26. A quantum information processing element according to claim 24, wherein at least some  
2 of the plurality of cargo elements are quantum information processing cargo elements
- 1 27. A quantum information processing element according to claim 24, wherein at least some  
2 of the plurality of cargo elements are non-quantum information processing cargo elements.
- 1 28. A quantum information processing element according to claim 1, wherein the cargo  
2 elements respond to stimuli internal and external to the cage.
- 1 29. A quantum information processing element according to claim 3, wherein a vesicle and  
2 its contained cargo elements respond to stimuli internal and external to the vesicle.
- 1 30. A quantum information processing element according to claim 24, wherein a subset of the  
2 non-quantum information processing cargo elements include one or more therapeutic agents.
- 1 31. A quantum information processing element according to claim 24, wherein a subset of  
2 the non-quantum information processing cargo elements include one or more diagnostic agents.
- 1 32. A quantum information processing element according to claim 24, wherein a subset of  
2 non-quantum information processing cargo elements include one or more sensor agents.
- 1 33. A quantum information processing element according to claim 24, wherein a subset of  
2 non-quantum information processing cargo elements include one or more prosthetic agents.
- 1 34. A quantum information processing element according to claim 24, wherein a subset of  
2 qubit and non-quantum information processing cargo elements include one or more quantum  
3 dots.
- 1 35. A quantum information processing element according to claim 24, wherein a subset of  
2 the cargo elements include one or more photonic dots.
- 1 36. A quantum information processing element according to claim 24, wherein a subset of  
2 the cargo elements include one or more liquids without dopants or with one or more dopants of  
3 any suitable type.

- 1 37. A quantum information processing element according to claim 24, wherein a subset of  
2 the cargo elements include a gas or vapor without dopants or with one or more dopants of any  
3 suitable type.
- 1 38. A quantum information processing element according to claim 1, wherein one or more  
2 qubit cargo elements are programmed by one or more pulses of electromagnetic radiation.
- 1 39. A quantum information processing element according to claim 38, wherein the  
2 electromagnetic radiation has a frequency in the UHF region.
- 1 40. A quantum information processing element according to claim 38, wherein the  
2 electromagnetic radiation has a frequency in the microwave region.
- 1 41. A quantum information processing element according to claim 38, wherein the  
2 electromagnetic radiation has a frequency in the radio region.
- 1 42. A quantum information processing element according to claim 1, wherein the qubit  
2 includes an unpaired electron and the plurality of logical states of the qubit are defined by  
3 electron spin polarization.
- 1 43. A quantum information processing element according to claim 1, wherein the qubit  
2 includes a nucleus and the plurality of logical states of the qubit are defined by nucleus spin  
3 polarization.
- 1 44. A quantum information processing element according to claim 1, wherein the qubit  
2 includes an unpaired electron and the plurality of logical states of the qubit are defined relative to  
3 an energy difference.
- 1 45. A quantum information processing element according to claim 1, wherein the qubit  
2 includes a nitroxide molecule.
- 1 46. A quantum information processing element according to claim 1, wherein the qubit  
2 includes a free radical molecule.
- 1 47. A quantum information processing element according to claim 1, wherein the qubit is  
2 photon-based and the plurality of logical states of the photon-based qubit include a coherent  
3 logical state.
- 1 48. A quantum information processing element according to claim 1, wherein the plurality of  
2 logical states includes a coherent state.
- 1 49. A quantum information processing element according to claim 1, wherein the plurality of  
2 logical states includes a coherent state at room temperature.

- 1 50. A quantum information processing element according to claim 1, wherein the self-  
2 assembling protein molecule is a clathrin molecule.
- 1 51. A quantum information processing element according to claim 1, wherein the cage  
2 comprises self-assembling synthetic protein molecules.
- 1 52. A quantum information processing element according to claim 4, wherein receptors,  
2 adaptors, and vesicle comprise natural or synthetic protein molecules.
- 1 53. A quantum information processing element according to claim 1, comprising a metallic  
2 coating on part or the entirety of the cage.
- 1 54. A quantum information processing element according to claim 4, comprising a metallic  
2 coating on a portion or an entirety of the receptors, adaptors, and vesicle.
- 1 55. A quantum information processing element according to claim 1, wherein the cage is  
2 substantially greater than one nanometer in diameter.
- 1 56. A quantum information processing element according to claim 1, wherein the cage is at  
2 least about 50 nanometers in diameter.
- 1 57. A quantum information processing element according to claim 1, wherein the cage is at  
2 least about 100 nanometers in diameter.
- 1 58. A quantum information processing element according to claim 1, wherein the cage is  
2 symmetric with respect to a plane.
- 1 59. A quantum information processing element according to claim 1, wherein the cage has  
2 icosahedral geometry.
- 1 60. A quantum information processing element according to claim 1, wherein qubits are  
2 linearly positioned at vertices along a single plane using circulant ordering.
- 1 61. A quantum information processing element according to claim 1, wherein multiple  
2 quantum information processing elements are physically linked together.
- 1 62. A quantum information processing element according to claim 1, wherein multiple self-  
2 assembling QIP elements are functionally linked together, either locally or at a distance.
- 1 63. A quantum information processing element according to claim 1, wherein the quantum  
2 information processing element forms a hybrid system upon its physical or functional integration  
3 with non-invention elements in vitro and in vivo.
- 1 64. A method for forming a quantum information processing element comprising

2           forming from self-assembling protein molecules a cage defining a cavity, and locating  
3 one or more cargo elements within the cavity, wherein  
4           at least one of the cargo elements comprises a qubit programmable into a plurality of  
5 logical states.